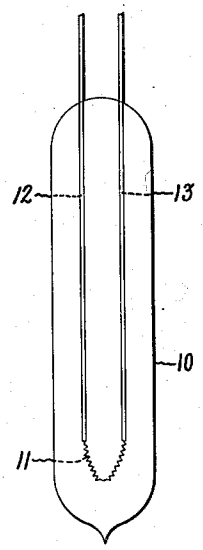
March 18, 1941. H. J. LEMMENS ET AL 2,235,713

ELECTRIC INCANDESCENT LAMP

Filed March 16, 1939



Inventors:
Hendricus J. Lemmens,
Josephus A.M. Smelt,
by Harry C. Dunham
Their Attorney.

Patented Mar. 18, 1941

2,235,713

UNITED STATES PATENT OFFICE

2,235,713

ELECTRIC INCANDESCENT LAMP

Hendricus J. Lemmens and Josephus A. M. Smelt, Eindhoven, Netherlands, assignors to General Electric Company, a corporation of New York

Application March 16, 1939, Serial No. 262,298
In Germany April 1, 1938

7 Claims. (Cl. 176—16)

Our invention relates to electric incandescent lamps in general, and more particularly to miniature lamps having a relatively high operating pressure and provided with relatively small envelopes or bulbs. Still more particularly, our invention relates to glass compositions for the bulbs of such lamps.

Electric incandescent lamps designed to operate at relatively high pressures are generally equipped with very small bulbs because of the high operating pressures, which may be higher than 20 atmospheres and even higher than 50 atmospheres, in order to thereby keep as small as possible the potential energy stored within the lamp bulb, that is, the product of the internal bulb volume and the pressure existing in the lamp. This minimization of the potential energy affords the possibility of using a rather thin bulb wall without any great danger of breakage. The vaporization of the filament material is kept within allowable limits by the particularly high pressure existing in the lamp during operation. In order to avoid, during the life of the lamp, detrimental results of the vaporized filament material with respect to the light emission, i. e., blackening of the bulb, and in order to provide an opportunity for this material to be deposited at those points of the bulb at which it practically is not detrimental to the light emission, the envelope or bulb is generally shaped more or less cylindrical. As a consequence, the internal diameter of such a small cylindrical bulb is necessarily rather small, with the result that the filament at certain points approaches very close to the bulb wall. Consequently the bulb wall will assume a very high temperature during the operation of the lamp.

In the small high-pressure incandescent lamps as constructed at present, it has become the practice in practically all cases to make the bulb of quartz because of the fact that quartz has a much higher softening point than the customary types of glass. Quartz, however, is rather expensive, and it has the further disadvantage that it cannot be made into the shape of an incandescent lamp bulb in the convenient manner that is customary for ordinary glass. If a small high-pressure incandescent lamp of the above-described type were to be equipped with a bulb of ordinary glass, then the danger would exist that the glass would soften during the operation of the lamp with the detrimental results connected therewith.

The bulb temperatures which are too high for ordinary glass, in the case of lamps with a particularly high operating pressure and a particularly small bulb volume, for instance of an order of magnitude of 15 cm.^{3} or less, are partly the result of the absorption by the wall of the bulb of a small part of the rays emitted by the filament. The applicants have come to the conclusion that particularly the iron compounds present in the glass play an important part in this respect.

One object of our invention is to provide a glass composition which can be successfully employed for the bulbs of small high-pressure electric incandescent lamps without danger of softening during operation of the lamp.

Another object of our invention is to provide a glass bulb, for lamps of the above-mentioned type, of a composition which will absorb a minimum amount of the rays emitted by the filament.

Still another object of our invention is to provide an electric incandescent lamp having a glass bulb in which at least 60 per cent of the iron compounds contained therein exist in the ferric state to thereby minimize the absorption of the infra-red rays emitted by the filament.

Further objects and advantages of our invention will appear from the following description of a species thereof and from the accompanying drawing which is an elevation of a small high-pressure electric incandescent lamp provided with a glass bulb comprising our invention.

Referring to the drawing, the lamp there shown comprises a relatively small cylindrical glass bulb or envelope 10 having a relatively small bulb volume, for instance 15 cm.^{3} or less. A filament 11, of a refractory metal such as tungsten, is mounted within the bulb 10 adjacent one end thereof by means of a pair of leading-in wires 12, 13 sealed into the glass of the bulb at the opposite end thereof. The filament 11 may be of the coiled or coiled-coil type. The bulb contains a gaseous filling, such as krypton or other rare gas, at a relatively high pressure, preferably above 4 atmospheres. The gaseous filling may have a pressure, in some cases, above 20 atmospheres and may even be in excess of 50 atmospheres.

The lamp according to the invention is characterized by the fact that the iron compounds present in the glass of the bulb 10 are present in an amount below 0.05 per cent by weight. The applicants have found that ferrous compounds are particularly detrimental since they absorb the infra-red rays emitted by the filament, which rays exist to a considerable extent in the spectrum of the filament. When the weight of the iron compounds in the bulb glass is selected in the manner

indicated above, then the bulb can be made of glass, which is of considerable advantage from the standpoint of their manufacture.

The possibility exists, of course, that the iron compounds present in the glass of the bulb may be made to occur in the form of ferric compounds. The ferric compounds particularly absorb the ultra-violet rays. Since in the spectrum of the above-described lamp, only a small quantity of ultra-violet radiation occurs, these ferric compounds are considerably less dangerous than the ferrous compounds. If care is taken, according to the invention, that the iron compounds present in the bulb glass, without danger of a premature softening, are, in an amount of at least 60 per cent, in the form of ferric compounds, then it will again become possible to make the bulb of glass instead of quartz as heretofore. The invention therefore makes it possible, when either one of the above-described types of glass is used, to utilize in the bulb of an incandescent lamp with a high operating pressure and a particularly small bulb volume, a higher wattage filament than in a glass bulb of the customary types of glass.

If desired, the iron compounds occurring in the glass can be converted during the manufacture of the glass at least partly into the harmless ferric compounds. It is possible, for instance, to perform the melting in a highly oxidizing flame, to add materials to the raw-material mixture for the glass which liberate oxygen, or to start with a more strongly basic composition of the raw-material mixture for the glass.

As a result of the fact that the lamp according to the invention has a relatively small bulb volume, the bulb is subjected to large temperature changes during the lamp operation, particularly when it is turned on and off. For that reason it is desirable to select a glass having a relatively low linear coefficient of expansion, preferably smaller than 45×10^{-7}, so that the stresses resulting from temperature changes are minimized.

It is also desirable that the glass of the bulb be free from lead, arsenic, and/or free from antimony since these materials absorb the ultra-violet part of the spectrum and would consequently cause a certain heat development in the glass walls of the bulb. In addition, there is always the danger, where these materials are present, of a reduction of the components of the glass.

Examples of a representative glass composition according to our invention are as follows:

Example I

SiO_2	78
B_2O_3	15
Al_2O_3	1
CaO	
MgO	
Na_2O	6
Fe_2O_3	0.05
FeO	0.03

or

Example II

SiO_2	55
B_2O_3	5
Al_2O_3	25
CaO	10
MgO	5
Na_2O	
Fe_2O_3	0.09
FeO	0.04

In those types of glasses specified herein-above in which at least 60 per cent of the iron compounds contained therein are present in the form of ferric compounds, it is necessary that the ferrous compounds forming the remaining percentages of the total iron content, are less than 0.05 percent by weight in order to prevent that the ferrous compound would cause the glass to soften by reason of absorption of the infra-red rays emitted by the filament.

As indicated hereinbefore, the term "glass" as used herein and in the appended claims is employed in its ordinary sense to mean an amorphous substance usually made by fusing together a mixture of some form of silica, an alkali and another base. This meaning of the term "glass" is intended to exclude quartz.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A miniature electric incandescent lamp of the high-intensity high-pressure gas-filled type with an operating pressure in excess of four atmospheres comprising a relatively small elongated envelope having a relatively thin wall and containing a metallic refractory filament disposed in relatively close relation to said wall and emitting, during operation, a high amount of infra-red rays, said envelope consisting of glass containing ferrous oxide in an amount not more than 0.05 per cent by weight of the glass composition.

2. A miniature electric incandescent lamp of the high-intensity high-pressure gas-filled type with an operating pressure in excess of four atmospheres comprising a relatively small elongated envelope having a relatively thin wall and containing a metallic refractory filament disposed in relatively close relation to said wall and emitting, during operation, a high amount of infra-red rays, said envelope consisting of glass containing iron oxides at least 60 per cent of which are in the form of ferric oxide, the remaining 40 per cent of iron oxides being in the form of ferrous oxide which is present in an amount not more than 0.05 per cent by weight of the total glass composition.

3. A miniature electric incandescent lamp of the high-intensity high-pressure gas-filled type with an operating pressure in excess of four atmospheres comprising a relatively small elongated envelope having a relatively thin wall and containing a metallic refractory filament disposed in relatively close relation to said wall and emitting, during operation, a high amount of infra-red rays, said envelope consisting of glass containing ferrous oxide in an amount not more than 0.05 per cent by weight of the glass composition and having a linear coefficient of expansion less than 45×10^{-7}.

4. A miniature electric incandescent lamp of the high-intensity high-pressure gas-filled type with an operating pressure in excess of four atmospheres comprising a relatively small elongated envelope having a relatively thin wall and containing a metallic refractory filament disposed in relatively close relation to said wall and emitting, during operation, a high amount of infra-red rays, said envelope consisting of glass containing ferrous oxide in an amount not more than 0.05 per cent by weight of the glass composition and being free from lead, arsenic and antimony.

5. A miniature electric incandescent lamp of the high-intensity high-pressure gas-filled type with an operating pressure in excess of four atmospheres comprising a relatively small elongated

envelope having a relatively thin wall and containing a metallic refractory filament disposed in relatively close relation to said wall and emitting, during operation, a high amount of infra-red rays, said envelope consisting of a borosilicate glass containing ferrous oxide in an amount not more than 0.05 per cent by weight of the glass composition.

6. A miniature electric incandescent lamp of the high-intensity high-pressure gas-filled type with an operating pressure in excess of four atmospheres comprising a relatively small elongated envelope having a relatively thin wall and containing a metallic refractory filament disposed in relatively close relation to said wall and emitting, during operation, a high amount of infra-red rays, said envelope consisting of a borosilicate glass containing iron oxides at least 60 per cent of which are in the form of ferric oxide, the remaining 40 per cent of iron oxides being in the form of ferrous oxide which is present in an amount not more than 0.05 per cent by weight of the total glass composition.

7. A miniature electric incandescent lamp of the high-intensity high-pressure gas-filled type with an operating pressure in excess of four atmospheres comprising a relatively thin-walled elongated envelope having a volume of the order of not more than 15 cc. and containing a concentrated metallic refractory filament which emits, during operation, a high amount of infra-red rays, said envelope consisting of glass containing ferrous oxide in an amount not more than 0.05 per cent by weight of the glass composition.

HENDRICUS J. LEMMENS.
JOSEPHUS A. M. SMELT.